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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "<u>Embedded -</u> <u>Microcontrollers</u>"

Details

E·XFI

Product Status	Active
Core Processor	PIC
Core Size	8-Bit
Speed	20MHz
Connectivity	-
Peripherals	POR, WDT
Number of I/O	12
Program Memory Size	768B (512 x 12)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	25 x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 5.5V
Data Converters	-
Oscillator Type	External
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	18-SOIC (0.295", 7.50mm Width)
Supplier Device Package	18-SOIC
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/pic16c54c-20e-so

Email: info@E-XFL.COM

Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong

2.0 PIC16C5X DEVICE VARIETIES

A variety of frequency ranges and packaging options are available. Depending on application and production requirements, the proper device option can be selected using the information in this section. When placing orders, please use the PIC16C5X Product Identification System at the back of this data sheet to specify the correct part number.

For the PIC16C5X family of devices, there are four device types, as indicated in the device number:

- 1. **C**, as in PIC16**C**54C. These devices have EPROM program memory and operate over the standard voltage range.
- LC, as in PIC16LC54A. These devices have EPROM program memory and operate over an extended voltage range.
- 3. **CR**, as in PIC16**CR**54A. These devices have ROM program memory and operate over the standard voltage range.
- 4. LCR, as in PIC16LCR54A. These devices have ROM program memory and operate over an extended voltage range.

2.1 UV Erasable Devices (EPROM)

The UV erasable versions offered in CERDIP packages, are optimal for prototype development and pilot programs.

UV erasable devices can be programmed for any of the four oscillator configurations. Microchip's

PICSTART[®] Plus⁽¹⁾ and PRO MATE[®] programmers both support programming of the PIC16C5X. Third party programmers also are available. Refer to the Third Party Guide (DS00104) for a list of sources.

2.2 One-Time-Programmable (OTP) Devices

The availability of OTP devices is especially useful for customers expecting frequent code changes and updates, or small volume applications.

The OTP devices, packaged in plastic packages, permit the user to program them once. In addition to the program memory, the configuration bits must be programmed.

Note 1: PIC16LC54C and PIC16C54A devices require OSC2 not to be connected while programming with PICSTART[®] Plus programmer.

2.3 Quick-Turnaround-Production (QTP) Devices

Microchip offers a QTP Programming Service for factory production orders. This service is made available for users who choose not to program a medium to high quantity of units and whose code patterns have stabilized. The devices are identical to the OTP devices but with all EPROM locations and configuration bit options already programmed by the factory. Certain code and prototype verification procedures apply before production shipments are available. Please contact your Microchip Technology sales office for more details.

2.4 Serialized Quick-Turnaround-Production (SQTPSM) Devices

Microchip offers the unique programming service where a few user defined locations in each device are programmed with different serial numbers. The serial numbers may be random, pseudo-random or sequential. The devices are identical to the OTP devices but with all EPROM locations and configuration bit options already programmed by the factory.

Serial programming allows each device to have a unique number which can serve as an entry code, password or ID number.

2.5 Read Only Memory (ROM) Devices

Microchip offers masked ROM versions of several of the highest volume parts, giving the customer a low cost option for high volume, mature products.

	Pi	n Numb	er	Pin	Buffer	
Pin Name	DIP	SOIC	SSOP	Туре	Туре	Description
RA0	17	17	19	I/O	TTL	Bi-directional I/O port
RA1	18	18	20	I/O	TTL	
RA2	1	1	1	I/O	TTL	
RA3	2	2	2	I/O	TTL	
RB0	6	6	7	I/O	TTL	Bi-directional I/O port
RB1	7	7	8	I/O	TTL	
RB2	8	8	9	I/O	TTL	
RB3	9	9	10	I/O	TTL	
RB4	10	10	11	I/O	TTL	
RB5	11	11	12	I/O	TTL	
RB6	12	12	13	I/O	TTL	
RB7	13	13	14	I/O	TTL	
TOCKI	3	3	3	I	ST	Clock input to Timer0. Must be tied to Vss or VDD, if not in use, to reduce current consumption.
MCLR/Vpp	4	4	4	I	ST	Master clear (RESET) input/programming voltage input. This pin is an active low RESET to the device. Voltage on the MCLR/VPP pin must not exceed VDD to avoid unin- tended entering of Programming mode.
OSC1/CLKIN	16	16	18	I	ST	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	15	15	17	0		Oscillator crystal output. Connects to crystal or resonator in crystal Oscillator mode. In RC mode, OSC2 pin outputs CLKOUT, which has 1/4 the frequency of OSC1 and denotes the instruction cycle rate.
Vdd	14	14	15,16	Р	_	Positive supply for logic and I/O pins.
Vss	5	5	5,6	Р	_	Ground reference for logic and I/O pins.

TABLE 3-1:PINOUT DESCRIPTION - PIC16C54, PIC16CR54, PIC16C56, PIC16CR56, PIC16CR58,
PIC16CR58

Legend: I = input, O = output, I/O = input/output, P = power, — = Not Used, TTL = TTL input, ST = Schmitt Trigger input

TABLE 5-3: RESET CONDITIONS FOR ALL REGISTERS

Register	Address	Power-On Reset	MCLR or WDT Reset
W	N/A	xxxx xxxx	uuuu uuuu
TRIS	N/A	1111 1111	1111 1111
OPTION	N/A	11 1111	11 1111
INDF	00h	xxxx xxxx	uuuu uuuu
TMR0	01h	XXXX XXXX	uuuu uuuu
PCL	02h	1111 1111	1111 1111
STATUS	03h	0001 1xxx	000q quuu
FSR ⁽¹⁾	04h	1xxx xxxx	luuu uuuu
PORTA	05h	xxxx	uuuu
PORTB	06h	XXXX XXXX	uuuu uuuu
PORTC ⁽²⁾	07h	XXXX XXXX	uuuu uuuu
General Purpose Register Files	07-7Fh	xxxx xxxx	սսսս սսսս

Legend: x = unknown u = unchanged - = unimplemented, read as '0'<math>q = see tables in Table 5-1 for possible values.

- Note 1: These values are valid for PIC16C57/CR57/CR58/CR58. For the PIC16C54/CR54/C55/C56/CR56, the value on RESET is 111x xxxx and for MCLR and WDT Reset, the value is 111u uuuu.
 - **2:** General purpose register file on PIC16C54/CR54/C56/CR56/C58/CR58.

FIGURE 5-1: SIMPLIFIED BLOCK DIAGRAM OF ON-CHIP RESET CIRCUIT



PIC16C5X



FIGURE 5-4: TIME-OUT SEQUENCE ON POWER-UP (MCLR TIED TO VDD): FAST VDD RISE TIME



FIGURE 5-5: TIME-OUT SEQUENCE ON POWER-UP (MCLR TIED TO VDD): SLOW VDD RISE TIME



6.0 MEMORY ORGANIZATION

PIC16C5X memory is organized into program memory and data memory. For devices with more than 512 bytes of program memory, a paging scheme is used. Program memory pages are accessed using one or two STATUS Register bits. For devices with a data memory register file of more than 32 registers, a banking scheme is used. Data memory banks are accessed using the File Selection Register (FSR).

6.1 Program Memory Organization

The PIC16C54, PIC16CR54 and PIC16C55 have a 9bit Program Counter (PC) capable of addressing a 512 x 12 program memory space (Figure 6-1). The PIC16C56 and PIC16CR56 have a 10-bit Program Counter (PC) capable of addressing a 1K x 12 program memory space (Figure 6-2). The PIC16CR57, PIC16C58 and PIC16CR58 have an 11-bit Program Counter capable of addressing a 2K x 12 program memory space (Figure 6-3). Accessing a location above the physically implemented address will cause a wraparound.

A NOP at the RESET vector location will cause a restart at location 000h. The RESET vector for the PIC16C54, PIC16CR54 and PIC16C55 is at 1FFh. The RESET vector for the PIC16C56 and PIC16CR56 is at 3FFh. The RESET vector for the PIC16C57, PIC16CR57, PIC16C58, and PIC16CR58 is at 7FFh. See Section 6.5 for additional information using CALL and GOTO instructions.

FIGURE 6-1: PIC16C54/CR54/C55 PROGRAM MEMORY MAP AND STACK



FIGURE 6-2:

PIC16C56/CR56 PROGRAM MEMORY MAP AND STACK



FIGURE 6-3:

PIC16C57/CR57/C58/ CR58 PROGRAM MEMORY MAP AND STACK



11.4 MPLINK Object Linker/ MPLIB Object Librarian

The MPLINK object linker combines relocatable objects created by the MPASM assembler and the MPLAB C17 and MPLAB C18 C compilers. It can also link relocatable objects from pre-compiled libraries, using directives from a linker script.

The MPLIB object librarian is a librarian for precompiled code to be used with the MPLINK object linker. When a routine from a library is called from another source file, only the modules that contain that routine will be linked in with the application. This allows large libraries to be used efficiently in many different applications. The MPLIB object librarian manages the creation and modification of library files.

The MPLINK object linker features include:

- Integration with MPASM assembler and MPLAB C17 and MPLAB C18 C compilers.
- Allows all memory areas to be defined as sections to provide link-time flexibility.

The MPLIB object librarian features include:

- Easier linking because single libraries can be included instead of many smaller files.
- Helps keep code maintainable by grouping related modules together.
- Allows libraries to be created and modules to be added, listed, replaced, deleted or extracted.

11.5 MPLAB SIM Software Simulator

The MPLAB SIM software simulator allows code development in a PC-hosted environment by simulating the PIC series microcontrollers on an instruction level. On any given instruction, the data areas can be examined or modified and stimuli can be applied from a file, or user-defined key press, to any of the pins. The execution can be performed in single step, execute until break, or trace mode.

The MPLAB SIM simulator fully supports symbolic debugging using the MPLAB C17 and the MPLAB C18 C compilers and the MPASM assembler. The software simulator offers the flexibility to develop and debug code outside of the laboratory environment, making it an excellent multiproject software development tool.

11.6 MPLAB ICE High Performance Universal In-Circuit Emulator with MPLAB IDE

The MPLAB ICE universal in-circuit emulator is intended to provide the product development engineer with a complete microcontroller design tool set for PIC microcontrollers (MCUs). Software control of the MPLAB ICE in-circuit emulator is provided by the MPLAB Integrated Development Environment (IDE), which allows editing, building, downloading and source debugging from a single environment.

The MPLAB ICE 2000 is a full-featured emulator system with enhanced trace, trigger and data monitoring features. Interchangeable processor modules allow the system to be easily reconfigured for emulation of different processors. The universal architecture of the MPLAB ICE in-circuit emulator allows expansion to support new PIC microcontrollers.

The MPLAB ICE in-circuit emulator system has been designed as a real-time emulation system, with advanced features that are generally found on more expensive development tools. The PC platform and Microsoft[®] Windows environment were chosen to best make these features available to you, the end user.

11.7 ICEPIC In-Circuit Emulator

The ICEPIC low cost, in-circuit emulator is a solution for the Microchip Technology PIC16C5X, PIC16C6X, PIC16C7X and PIC16CXXX families of 8-bit One-Time-Programmable (OTP) microcontrollers. The modular system can support different subsets of PIC16C5X or PIC16CXXX products through the use of interchangeable personality modules, or daughter boards. The emulator is capable of emulating without target application circuitry being present.

11.13 PICDEM 3 Low Cost PIC16CXXX Demonstration Board

The PICDEM 3 demonstration board is a simple demonstration board that supports the PIC16C923 and PIC16C924 in the PLCC package. It will also support future 44-pin PLCC microcontrollers with an LCD Module. All the necessary hardware and software is included to run the basic demonstration programs. The user can program the sample microcontrollers provided with the PICDEM 3 demonstration board on a PRO MATE II device programmer, or a PICSTART Plus development programmer with an adapter socket, and easily test firmware. The MPLAB ICE in-circuit emulator may also be used with the PICDEM 3 demonstration board to test firmware. A prototype area has been provided to the user for adding hardware and connecting it to the microcontroller socket(s). Some of the features include a RS-232 interface, push button switches, a potentiometer for simulated analog input, a thermistor and separate headers for connection to an external LCD module and a keypad. Also provided on the PICDEM 3 demonstration board is a LCD panel, with 4 commons and 12 segments, that is capable of displaying time, temperature and day of the week. The PICDEM 3 demonstration board provides an additional RS-232 interface and Windows software for showing the demultiplexed LCD signals on a PC. A simple serial interface allows the user to construct a hardware demultiplexer for the LCD signals.

11.14 PICDEM 17 Demonstration Board

The PICDEM 17 demonstration board is an evaluation board that demonstrates the capabilities of several Microchip microcontrollers, including PIC17C752, PIC17C756A, PIC17C762 and PIC17C766. All necessary hardware is included to run basic demo programs, which are supplied on a 3.5-inch disk. A programmed sample is included and the user may erase it and program it with the other sample programs using the PRO MATE II device programmer, or the PICSTART Plus development programmer, and easily debug and test the sample code. In addition, the PICDEM 17 demonstration board supports downloading of programs to and executing out of external FLASH memory on board. The PICDEM 17 demonstration board is also usable with the MPLAB ICE in-circuit emulator, or the PICMASTER emulator and all of the sample programs can be run and modified using either emulator. Additionally, a generous prototype area is available for user hardware.

11.15 KEELOQ Evaluation and Programming Tools

KEELOQ evaluation and programming tools support Microchip's HCS Secure Data Products. The HCS evaluation kit includes a LCD display to show changing codes, a decoder to decode transmissions and a programming interface to program test transmitters.

13.5 Timing Parameter Symbology and Load Conditions

The timing parameter symbols have been created with one of the following formats:

1. TppS2ppS

2. Tp	pS	
Т		
F	Frequency	T Time
Lowe	ercase letters (pp) and their meanings:	
рр		
2	to	mc MCLR
ck	CLKOUT	osc oscillator
су	cycle time	os OSC1
drt	device reset timer	t0 T0CKI
io	I/O port	wdt watchdog timer
Uppe	ercase letters and their meanings:	
S		
F	Fall	P Period
Н	High	R Rise
Ι	Invalid (Hi-impedance)	V Valid
L	Low	Z Hi-impedance

FIGURE 13-1: LOAD CONDITIONS FOR DEVICE TIMING SPECIFICATIONS - PIC16CR54A





FIGURE 13-4: RESET, WATCHDOG TIMER, AND DEVICE RESET TIMER TIMING - PIC16CR54A

TABLE 13-3: RESET, WATCHDOG TIMER, AND DEVICE RESET TIMER - PIC16CR54A

AC Chara	$ \begin{array}{c} \mbox{Standard Operating Conditions (unless otherwise specified)} \\ \mbox{Operating Temperature} & 0^\circ C \leq TA \leq +70^\circ C \mbox{ for commercial} \\ -40^\circ C \leq TA \leq +85^\circ C \mbox{ for industrial} \\ -40^\circ C \leq TA \leq +125^\circ C \mbox{ for extended} \end{array} $						
Param No.	Symbol	Characteristic	Min	Тур†	Max	Units	Conditions
30	TmcL	MCLR Pulse Width (low)	1.0*	_	_	μS	VDD = 5.0V
31	Twdt	Watchdog Timer Time-out Period (No Prescaler)	7.0*	18*	40*	ms	VDD = 5.0V (Comm)
32	Tdrt	Device Reset Timer Period	7.0*	18*	30*	ms	VDD = 5.0V (Comm)
34	Tioz	I/O Hi-impedance from MCLR Low	_	_	1.0*	μS	

These parameters are characterized but not tested.

† Data in the Typical ("Typ") column is at 5.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

FIGURE 14-6: MAXIMUM IPD vs. VDD, WATCHDOG DISABLED



FIGURE 14-7: TYPICA

TYPICAL IPD vs. VDD, WATCHDOG ENABLED



FIGURE 14-8: MAXIMUM IPD vs. VDD, WATCHDOG ENABLED



IPD, with WDT enabled, has two components: The leakage current, which increases with higher temperature, and the operating current of the WDT logic, which increases with lower temperature. At -40° C, the latter dominates explaining the apparently anomalous behavior.









FIGURE 17-8: RESET, WATCHDOG TIMER, AND DEVICE RESET TIMER TIMING - PIC16C5X, PIC16CR5X

TABLE 17-3: RESET, WATCHDOG TIMER, AND DEVICE RESET TIMER - PIC16C5X, PIC16CR5X

$\label{eq:AC Characteristics} \begin{tabular}{lllllllllllllllllllllllllllllllllll$							
Param No.	Symbol	Characteristic	Min	Тур†	Max	Units	Conditions
30	TmcL	MCLR Pulse Width (low)	1000*		—	ns	VDD = 5.0V
31	Twdt	Watchdog Timer Time-out Period (No Prescaler)	9.0*	18*	30*	ms	VDD = 5.0V (Comm)
32	Tdrt	Device Reset Timer Period	9.0*	18*	30*	ms	VDD = 5.0V (Comm)
34	Tioz	I/O Hi-impedance from MCLR Low	100*	300*	1000*	ns	

* These parameters are characterized but not tested.

† Data in the Typical ("Typ") column is at 5V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

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18.0 DEVICE CHARACTERIZATION - PIC16LC54A

The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

"Typical" represents the mean of the distribution at 25°C. "Maximum" or "minimum" represents (mean + 3σ) or (mean - 3σ) respectively, where σ is a standard deviation, over the whole temperature range.



FIGURE 18-1: TYPICAL RC OSCILLATOR FREQUENCY vs. TEMPERATURE

TABLE 18-1: RC OSCILLATOR FREQUENCIES

Сехт	Rext	Average Fosc @ 5V, 25°C		
20 pF	3.3K	5 MHz	± 27%	
	5K	3.8 MHz	± 21%	
	10K	2.2 MHz	± 21%	
	100K	262 kHz	± 31%	
100 pF	3.3K	1.63 MHz	± 13%	
	5K	1.2 MHz	± 13%	
	10K	684 kHz	± 18%	
	100K	71 kHz	± 25%	
300 pF	3.3K	660 kHz	± 10%	
	5.0K	484 kHz	± 14%	
	10K	267 kHz	± 15%	
	100K	29 kHz	± 19%	

The frequencies are measured on DIP packages.

The percentage variation indicated here is part-to-part variation due to normal process distribution. The variation indicated is ± 3 standard deviation from average value for VDD = 5V.



FIGURE 18-4: TYPICAL RC OSCILLATOR FREQUENCY vs. VDD, CEXT = 300 PF, 25°C



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TABLE 18-2:INPUT CAPACITANCE

Bin	Typical Capacitance (pF)			
FIII	18L PDIP	18L SOIC		
RA port	5.0	4.3		
RB port	5.0	4.3		
MCLR	17.0	17.0		
OSC1	4.0	3.5		
OSC2/CLKOUT	4.3	3.5		
TOCKI	3.2	2.8		

All capacitance values are typical at 25° C. A part-to-part variation of ±25% (three standard deviations) should be taken into account.

APPENDIX A: COMPATIBILITY

To convert code written for PIC16CXX to PIC16C5X, the user should take the following steps:

- 1. Check any CALL, GOTO or instructions that modify the PC to determine if any program memory page select operations (PA2, PA1, PA0 bits) need to be made.
- 2. Revisit any computed jump operations (write to PC or add to PC, etc.) to make sure page bits are set properly under the new scheme.
- 3. Eliminate any special function register page switching. Redefine data variables to reallocate them.
- 4. Verify all writes to STATUS, OPTION, and FSR registers since these have changed.
- 5. Change RESET vector to proper value for processor used.
- 6. Remove any use of the ADDLW, RETURN and SUBLW instructions.
- 7. Rewrite any code segments that use interrupts.

APPENDIX B: REVISION HISTORY

Revision KE (January 2013)

Added a note to each package outline drawing.

PIC16C5X

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Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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ISBN: 9781620769355

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